Fishery Data Series No. 01-23

Stock Assessment and Biological Characteristics of Burbot in Fielding Lake During 2000

by

James F. Parker

December 2001

Alaska Department of Fish and Game **Division of Sport Fish**

Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used in Division of Sport Fish Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications without definition.

Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
metric ton	mt
milliliter	ml
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

All commonly accepted abbreviations.	e.g., Mr., Mrs., a.m., p.m., etc.
All commonly accepted professional titles.	e.g., Dr., Ph.D., R.N., etc.
and	&
at	@
Compass directions:	
east	E
north	N
south	S
west	W
Copyright	©
Corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
et alii (and other people)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.,
id est (that is)	i.e.,
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
number (before a number)	# (e.g., #10)
pounds (after a number)	# (e.g., 10#)
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S. state and District of Columbia abbreviations	use two-letter abbreviations (e.g., AK, DC)

Mathematics, statistics, fisheries

alternate hypothesis	H_A
base of natural logarithm	e
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	F, t, χ^2, etc.
confidence interval	C.I.
correlation coefficient	R (multiple)
correlation coefficient	r (simple)
covariance	cov
degree (angular or temperature)	°
degrees of freedom	df
divided by	÷ or / (in equations)
equals	=
expected value	E
fork length	FL
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
mideye-to-fork	MEF
minute (angular)	'
multiplied by	x
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
standard length	SL
total length	TL
variance	Var

FISHERY DATA SERIES NO. 01-23

STOCK ASSESSMENT AND BIOLOGICAL CHARACTERISTICS OF BURBOT IN FIELDING LAKE DURING 2000

by
James F. Parker
Division of Sport Fish, Delta Junction

Alaska Department of Fish and Game
Division of Sport Fish, Research and Technical Services
333 Raspberry Road, Anchorage, Alaska, 99518-1599

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James F. Parker
Alaska Department of Fish and Game, Division of Sport Fish
P.O. Box 605, Delta Jct., AK 99737-0605, USA

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ABSTRACT

Abundance and an index of abundance were estimated for a population of burbot *Lota lota* in Fielding Lake. Burbot were captured in baited hoop traps set in a systematic pattern across Fielding Lake. Sampling occurred June 18-25 of 2000. Estimated mean CPUE per 48-h set of fully (450 mm TL and longer) and partially (300 to 449 mm TL) recruited burbot in Fielding Lake was 1.32 (SE = 0.15) and 0.47 (SE = 0.09), respectively. In 1999, estimated abundance of fully recruited burbot was 598 (SE = 62). An estimated density of fully recruited burbot was 1.1 (SE = 0.11) fish per hectare. An estimated 74.9% (SE = 7.5) fully recruited burbot survived from 1998 to 1999.

Key words: burbot, *Lota lota*, lakes, abundance, hoop traps, systematic design, mean length, catch-per-unit of effort, abundance estimates, survival rates, recruitment.

INTRODUCTION

Harvests of burbot *Lota lota* from Interior lakes increased, on average, 30% annually from 1977 to 1983, with the largest harvest occurring during the years 1984 to 1986 (Howe et al. 2000a). The lakes in the Glennallen area (Southcentral Alaska) have historically supported the largest component of this harvest. Harvest of burbot in the Tanana River drainage has recently fluctuated from approximately 5,700 to 2,000 (Figure 1).

Burbot harvests have declined in lakes of interior Alaska (Figure 1) since peak harvests in the mid-1980s. This decline in harvests may be attributed to decreasing abundance of burbot in lakes due to overfishing and more restrictive regulations governing sport fisheries. Emergency regulations adopted in 1987 and other regulations since then have restricted bag and possession limits to two fish and eliminated the use of set lines as a legal method of sport fishing in the Upper-Copper/Upper Susitna management area; Fielding, T; and Harding lakes, and throughout the Tangle Lakes system. Regulations for other lake populations in the Tanana River drainage are a daily bag and possession limit of five burbot and a maximum of five hooks fished at any one time.

From 1981-1984 harvests of burbot in Fielding Lake averaged 330 per year (Mills 1982-1985; Figure 2). These large harvests may have resulted in low abundance in 1987 (Figure 2). Declines in abundance occurred again in 1992 and to a lesser extent in 1996 even though between1983 and 1997 there was no reported harvest in nine of those years and harvest of less than 75 burbot in the remaining six years (Mill 1985-1994; Howe et al. 1995 and 1996; Howe et al. 2000a-d; Figure 2). On May 26, 1994, the Alaska Department of Fish and Game (ADF&G) issued an emergency order closing Fielding Lake to the taking of burbot until further notice. After significant increases in the population in 1998 and 1999 the department in March 2000 submitted a proposal to the Alaska Board of Fisheries (BOF) to allow a one fish bag limit. In January 2001, the BOF passed a regulation that allows a daily bag and possession limit of one burbot, prohibits the use of setlines, allows only single hooks to be used, and closes the fishery from September 1-30.

In 1986, the Sport Fish Division of ADF&G initiated a stock assessment program for burbot populations in the Upper Copper/Upper Susitna basin and in the Tanana River drainage (Parker et al. 1987-1989; Parker 1993-2000; Lafferty et al. 1990-1992; Lafferty and Bernard 1993; and Taube et al. 1994-1995, and 2000). This document is the fifteenth report of the findings from this research. The objectives of the program in 2000 were:

Data from (Mills 1979-1994, Howe et al. 1995, 1996 and 2000a-d)

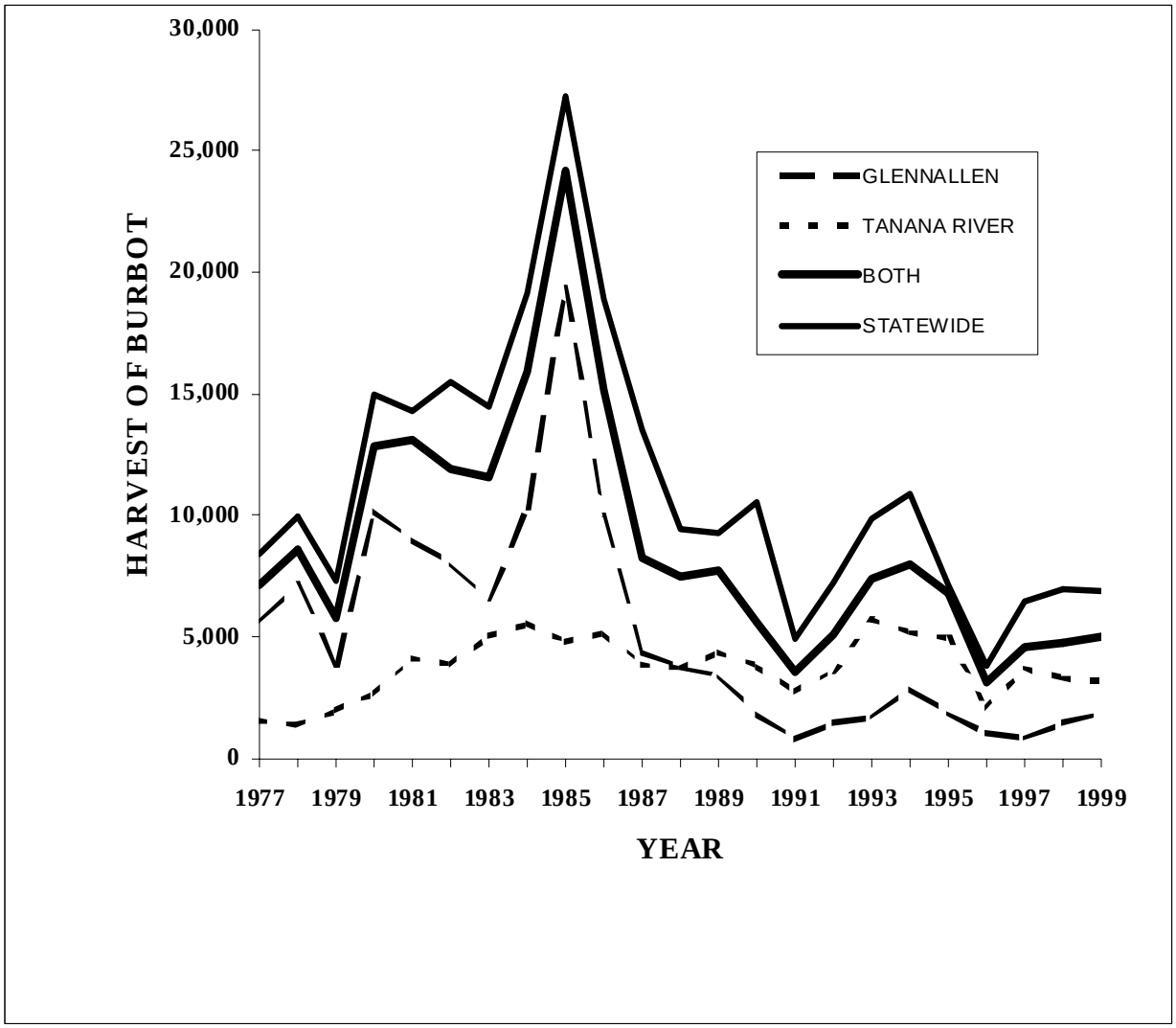

Figure 1.-Harvests of burbot in Alaskan fisheries, 1977-1999

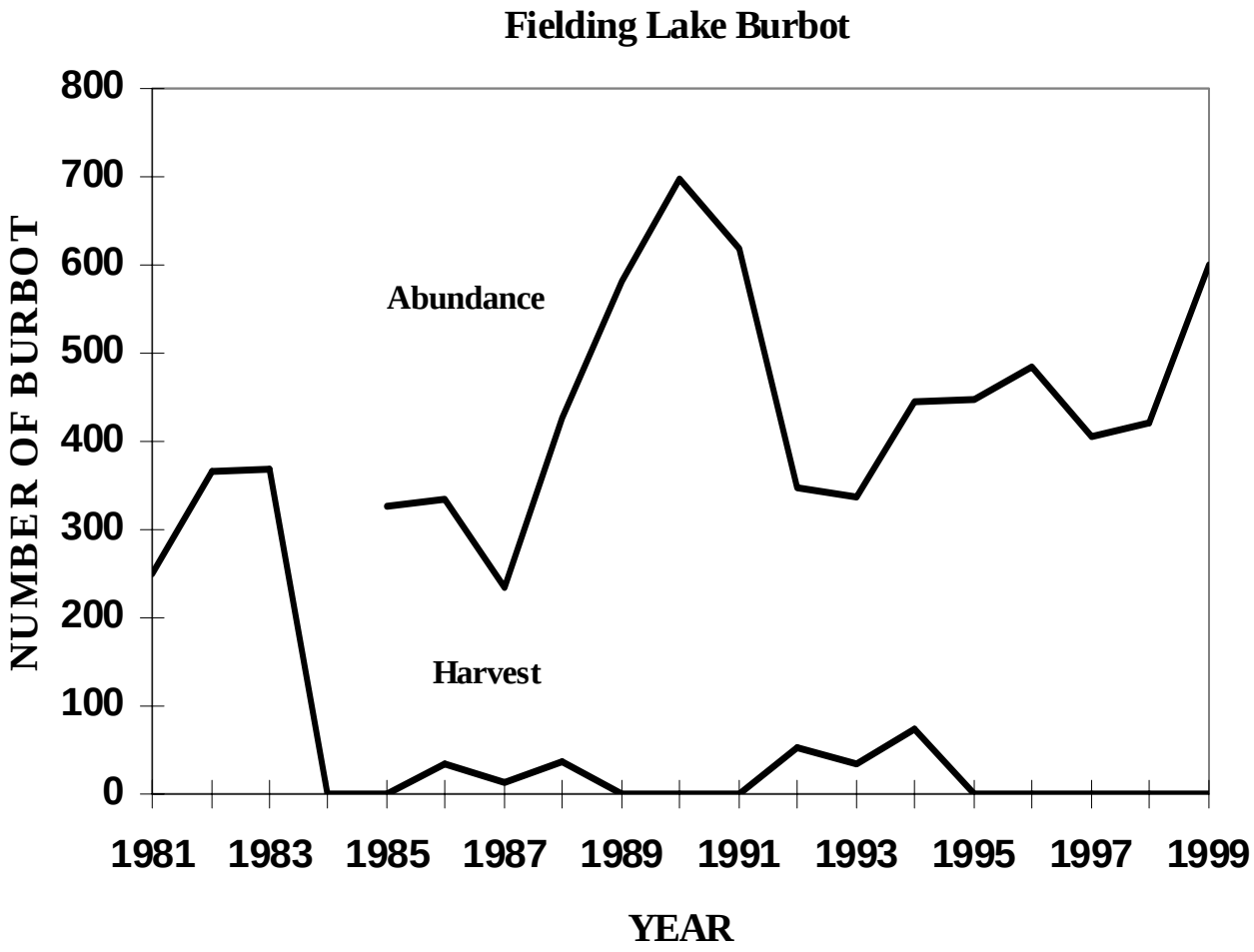

Figure 2.-Annual harvest and abundance of burbot (≥ 450 mm TL) in Fielding Lake, 1981-1999.

1. estimate the abundance in 1999 and survival rate from 1998 to 1999 for burbot $\geq$ 450 mm total length (TL) in Fielding Lake, such that each estimate will be within $\pm$ 25% of the actual value 90% of the time; and,
2. index abundance of burbot $\geq$ 450 mm TL in Fielding Lake in 2000 with mean catch-per-unit-effort (CPUE) in sampling gear such that calculated mean CPUE is within ± 25 % of asymptotic value 90% of the time.

Burbot of Fielding Lake (63^{o}10' N, 145^{o} 42' W) are geographically isolated from other lakes by a lengthy river and accessible to fishermen by road from the Richardson Highway (Figure 3). The surface area of the lake is 538 ha, the maximum depth is 24 m, and the elevation of the lake is 906 m (Appendix A5). Three inlet streams feed the lake and one outlet stream located on the north end drains the lake. The lake begins to freeze by the middle of October and breakup occurs from 15 June to 1 July. Campground and boat launch facilities are located near the outlet of the lake, and several recreational cabins are located along the south shore. In addition to burbot, Fielding Lake contains Arctic grayling *Thymallus arcticus*, lake trout *Salvelinus namaycush*, and round whitefish *Prosopium cylindraceum*.

METHODS

GEAR DESCRIPTION

Burbot were captured in hoop traps that were 3.05 m in length and constructed with seven 6.35 mm steel hoops (Figure 4). Hoop diameters tapered from 0.61 m at the entrance to 0.46 m at the cod end. Each trap was double-throated (tied to the first and third hoop) with throats narrowing to an opening 10 cm in diameter. All netting material was knotted nylon 25-mm bar meshes, held together with No. 15 cotton twine, and treated with an asphaltic compound. Each trap was stretched with two sections of 12 mm galvanized steel conduit that was attached by snap clips to the end hoops of the trap. A numbered buoy was attached to the cod end of the trap with a polypropylene rope. Each trap was baited with Pacific herring *Clupea pallasi* cut into chunks and placed in a 500 ml perforated plastic, screw-top container. Bait containers were placed in the cod end of the hoop trap. Each hoop trap was soaked for approximately 48 h (hereafter referred to as a set) to maximize the catch of burbot (Bernard et al. 1991).

STUDY DESIGN

Mean CPUE was estimated with a two-stage, systematic survey of 240 sets from 20-25 June 2000. First, an overlay of parallel lines was placed across a map of Fielding Lake at a randomly chosen position but with the lines in the overlay perpendicular to the long axis of the lake. Distances between adjacent lines[1] in the overlay represented 125 m. Each parallel line also had tick marks with the distance between marks representing125 m. Next, the desired number of sets was compared with the number of tick marks that were over the water on the map; parallel lines were randomly excluded until the total number of tick marks and the desired number of sets were similar. Traps were set in the remaining transects. The location of the first set along each transect was randomly chosen (from one of five 25 m ticks from shore), and every subsequent set was placed along that transect at 125 m from the

[1] The distance between traps of 125 m was chosen to eliminate gear competition. The effective fishing area of a baited trap was estimated at 0.45 ha by dividing the average CPUE of burbot caught per 48-h set in 1985 in Fielding Lake by the density of burbot per ha from the mark-recapture experiment (Pearse and Conrad 1986). This estimated fishing area was arbitrarily increased to 1.25 ha to ensure elimination of gear competition; this area corresponds to traps set at a distance of 125 m.

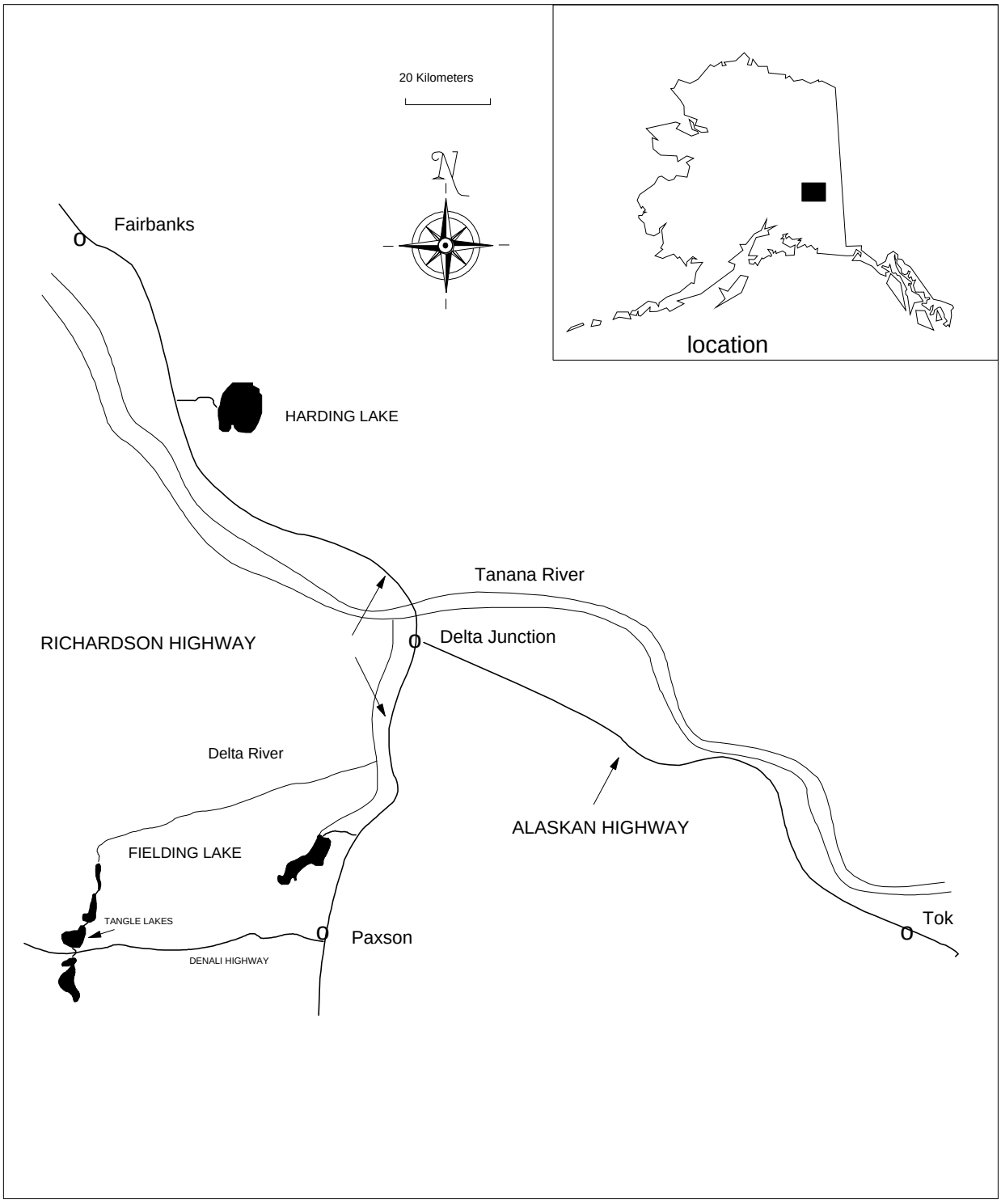

Figure 3.-Location of Fielding Lake in the Tanana River drainage.

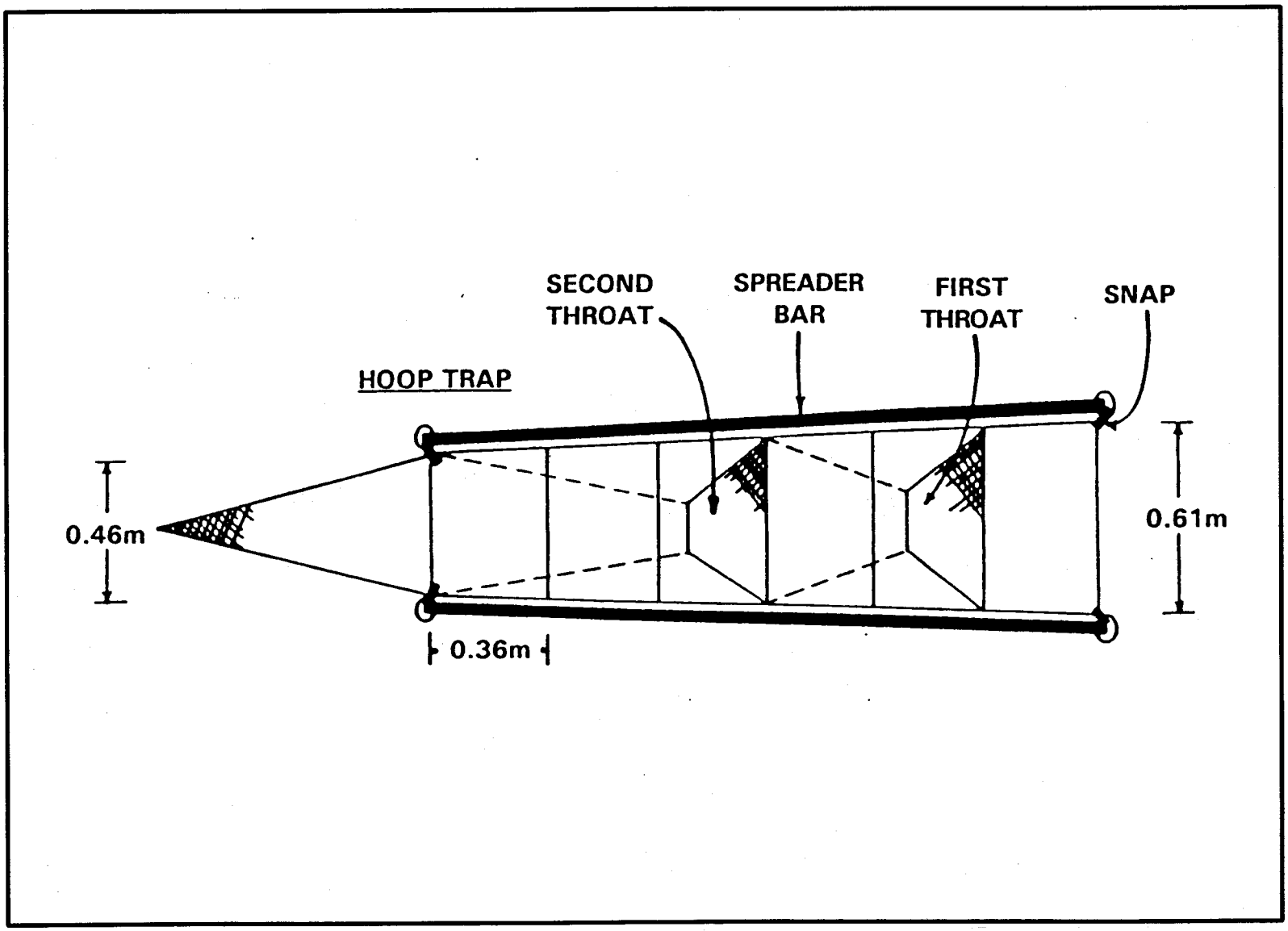

Figure 4.-Schematic drawing of hoop traps used to catch burbot during 2000 at Fielding Lake.

last set. The desired number of sets for each survey in the mark-recapture experiment was based on converting sample sizes as calculated by Robson and Regier (1964) into number of sets using a *previous* estimate of mean CPUE and catchability. The desired numbers of sets to estimate mean CPUE as an index of abundance were calculated with procedures in Cochran (1977) for determining sample size to estimate the mean of a continuous variable. Desired sample sizes for both mean CPUE and abundance were calculated, and the larger number was used.

Traps were immersed and retrieved during daylight hours beginning on one end of the lake and progressing to the other end. A single crew of three persons (one person piloted the boat and recorded data while the other two handled traps, measured, and tagged captured burbot) immersed and retrieved traps simultaneously. The crew immersed and retrieved 60 traps in an eight-hour workday. Every new set received fresh bait, and old bait was discarded on shore.

Captured fish from each trap were placed into a plastic tub to await sampling. The length of each burbot was measured and those $\geq$300 mm TL were doubly marked. Burbot were tagged with an individually numbered internal anchor tag inserted in the musculature beneath the dorsal fin. Throughout the mark-recapture experiment, tags were used in serial order to allow easy recognition of specific locations and sampling events. The second mark, which was used to evaluate loss of tags in 2000, was a right ventral finclip. Any burbot that was stressed from deep-water removal (usually resulting in an expanded gas bladder) or had trap-inflicted injuries was killed and dissected. Otoliths were removed, and the sex, weight (kg), and maturity of these burbot were recorded. Ages were estimated from whole, polished otoliths by counting annuli according to the method of Beamish and McFarlane (1987) and Chilton and Beamish (1982).

Burbot in Fielding Lake were separated into two groups for analysis: those fully recruited to the hoop traps ($\geq$ 450 mm TL, adults) and those partially recruited (< 450 mm TL, juveniles). Bernard et al. (1991) showed that burbot recruited fully to the hoop trap gear between 450 and 500 mm TL in most populations. In addition, juveniles (fish 300 – 449 mm TL) were not fully recruited to the gear. Potential biases in estimating abundance from differences in capture rates between juvenile and adult burbot can be avoided through stratification of the population into these two groups as was done here. Estimated Jolly-Seber abundance and abundance generated from catchability coefficients are for adult burbot only. However, statistical biases in mean CPUE for both adult and juvenile burbot are negligible (Bernard et al 1993). The value of including CPUE data for juvenile burbot is in tracking depth preference, seasonal movements, distribution, seasonal catch rates, and handling-related mortality, which have been reported in previous reports. Fish recaptured multiple times during this single event experiment were only considered once to estimate abundance, but were considered in the sample each time to estimate mean CPUE.

MEAN CPUE

Mean CPUE was estimated in Fielding Lake for fully recruited and partially recruited burbot following a two-stage sampling design with transects as first-stage units and sets along transects as second-stage units (Sukhatme et al. 1984). Although all transects had an equal probability of being included in a survey, they were of different sizes (lengths) depending upon the shape (width) of the lake. Under these conditions, the unbiased estimate of mean CPUE was:

$$\overline{CPUE} = \frac{1}{n} \sum_{i=1}^{n} \frac{1}{m_i} \left[\sum_{j=1}^{m_i} x_i c_{ij} \right] \quad (1)$$

where:

c_{ij} = catch of burbot from the jth set on the ith transect;

n = number of transects sampled;

m_i = number of sets sampled on the ith transect;

x_i = $M_i / \overline{M}$;

M_i = maximum possible sets on the ith transect; and,

$\overline{M}$ = mean of possible sets across all transects.

Although the M_i and $\overline{M}$ are unknown, mean CPUE can still be estimated by substituting m_i and $\overline{m}$ for M and $\overline{M}$. This substitution is valid because both M and m are directly related to the length of transects.

Thus $\hat{x}_i = m_i / \overline{m}$ was inserted for x_i. Because few burbot enter traps during daylight (Bernard et al. 1991), catches were not adjusted for the few hours deviation in soak times from the standard 48-h for most sets. Although the distribution of burbot can be related to depth (Odell 1932; Kennedy 1940; Rawson 1951; Dryer 1966), the estimate of mean CPUE was not poststratified by depth. A two-stage, resampling procedure (Efron 1982, Rao and Wu 1988) was used to generate an empirical distribution of mean CPUE for each survey from which variance and any statistical bias in mean CPUE were estimated (Bernard et al. 1993). The variances produced are conservative in the sense that finite population correction factors were ignored in the modification of Rao and Wu (1988).

ABUNDANCE, SURVIVAL RATES, AND RECRUITMENT

Abundance, survival rates, and surviving recruitment of fully recruited burbot were estimated using the mark-recapture histories of fish according to the models of Jolly (1965) and Seber (1965 and 1982). The computer program Jolly (model A) as described in Pollock et al. (1985 and 1990) was used to do the calculations. Mark-recapture histories for the population are listed in Appendices A1 and A2. In earlier years, two-event mark-recapture experiments based on closed populations were used to estimate abundance of burbot. Both events were a few weeks apart. Data from these experiments were pooled to form the annual sampling events used in the multi-year mark-recapture experiment as recommended by Pollock (1982). Since mark-recapture experiments with one annual sampling event do not produce estimates of abundance for the current year of sampling, mean CPUE was used to estimate abundance of burbot in 2000 using the relationship:

$$\hat{N} = A\overline{(CPUE)}\hat{q}^{-1} \quad (2)$$

where A is the surface area the lake, and q is the catchability coefficient (the fraction of the population present in a hectare that is removed instantaneously with one unit of sampling effort, i.e., a set). Estimates of $\hat{q}$ were obtained from previous sampling in Fielding Lake (see Lafferty and Bernard 1993; Parker 1994-2000). Since catchability of burbot in hoop traps is about 1.5 times higher just after lakes become ice-free than later in the summer (Bernard et al. 1993), only information from past sampling events that matched the scheduling with the sampling event in 2000 was used to estimate an average q.

RESULTS

Length distributions of burbot $\geq$ 450 mm total length (TL) in 2000 were not significantly different from 1999 (Kolmogorov-Smirnov two-sample test, D = 0.07, p = 0.85; Figure 5). The mean length of burbot $\geq$ 450 mm total length (TL) was 530 mm TL in 2000 (Table 1). The length distribution in 2000 shows the greatest number of fish were caught in the 450-500 mm range (Figure 6). Fully recruited burbot released in 1999 and recaptured in 2000 grew an average of 43 mm (n = 187).

In 2000, estimated mean CPUE (bootstrapped) of burbot $\geq$ 450 mm total length (TL) was 1.32 burbot (SE = 0.15) per set (Table 2). Estimated bias in mean CPUE for burbot $\geq$ 450 mm total length (TL) calculated through bootstrapping was negligible (< 1%). Sets were most numerous between 9-12 m with burbot being caught at all depths (Figure 7).

The Jolly-Seber estimate of abundance of fully recruited burbot in 1999 was 598 burbot (SE = 62; Table 3). Annual survival rate from 1998-1999 was estimated at 75%, and recruitment was estimated at 283 burbot (Table 3). Density of fully recruited burbot in 1999 was 1.11 fish per hectare (SE = 0.11) (Table 4). Rate of overwinter tag loss was <1% for fully recruited burbot. Throughout the mark-recapture experiment, there was no evidence of regenerated fins on any of the recaptured burbot with tags. In 2000, four fish were killed incidental to sampling. Sex, age, length, weight, and maturity information collected from these fish are found in Appendix A3. Appendix A4 provides a listing of the data archives.

DISCUSSION

Statistically, the length distribution between 1999 and 2000 are the same (Figure 5). The mode of the distribution (503 mm) is nearly the same as reported in 1999 (500 mm; Parker 2000). Estimated mean CPUE for burbot $\geq$ 450 mm total length (TL) declined annually from 0.71 in 1991 (Lafferty et al. 1992) to 0.32 in 1993 (Parker 1994). This trend reversed in 1994, with the mean CPUE increasing to 0.54 in 1995 (Parker 1996), 0.67 in 1997 (Parker 1998), 0.84 in 1998 (Parker 1999), 1.09 in 1999 (Parker 2000), and 1.32 in 2000 (Figure 8).

A temporary abundance estimate is generated for the current year by expanding the CPUE using the average catchability coefficient (Lafferty and Bernard 1993). It is a rudimentary estimate of abundance used until the Jolly-Seber model can supply a more reliable one the following year. The estimate using the mean CPUE for 1999 and catchability coefficient predicted a larger number of fish ($\hat{N}$ = 759) for 1999 (Parker 2000), than the estimate of 598 using mark-recapture techniques (Table 4). Likewise for 2000, the CPUE expanded estimate was 917 burbot, which is higher than expected. Increases in abundance for the fully recruited portion

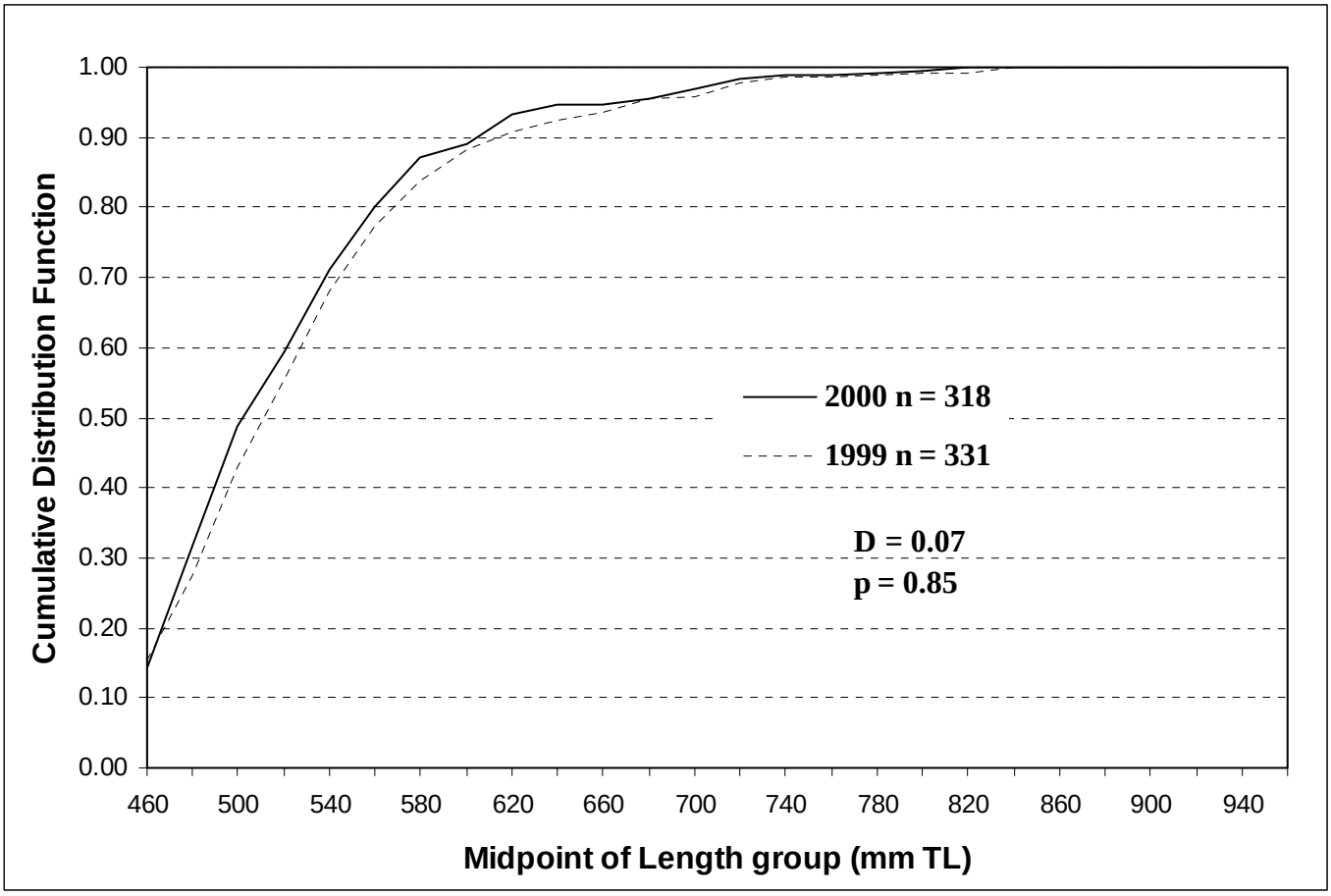

Figure 5.-Cumulative distribution function of length groups of fully recruited burbot captured in Fielding Lake during 1999 and 2000.

Table 1.-Mean lengths (mm TL) of burbot measured during the 2000 sampling event at Fielding Lake.

Statistic	Length Class [a]		
	< 450 mm TL	≥ 450 mm TL	All
Mean	409	530	498
SE	4	4	4
Samples	111	317	430

[a] Burbot partially recruited to the gear are < 450 mm TL and fully recruited burbot are ≥ 450 mm TL.

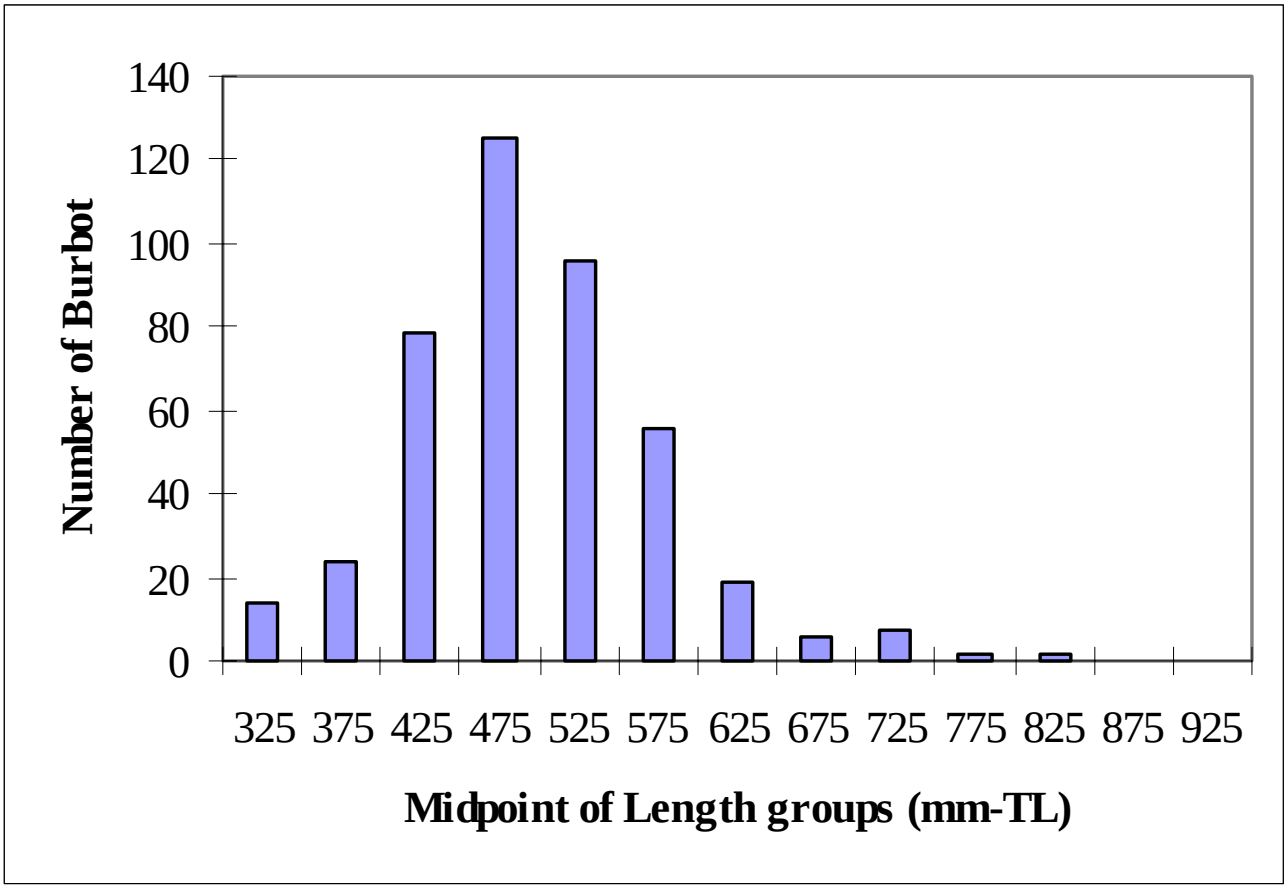

Figure 6.-Number of burbot by length group of burbot captured in 2000 at Fielding Lake.

Table 2.-Estimated mean CPUE of fully recruited (≥ 450 mm TL) and partially recruited (< 450 mm TL) burbot from systematic sampling of the population in 2000 at Fielding Lake.

Dates	Strata	Number of Sets and Transects		Mean CPUE Bootstrapped	Mean CPUE Arithmetic	%D	(SE)	CV%
Fully Recruits:								
6/20-25	All depths	239	34	1.32	1.32	0.1	0.15	11.6
Partial Recruits:								
6/20-25	All depths	239	34	0.47	0.47	-0.5	0.08	18.4

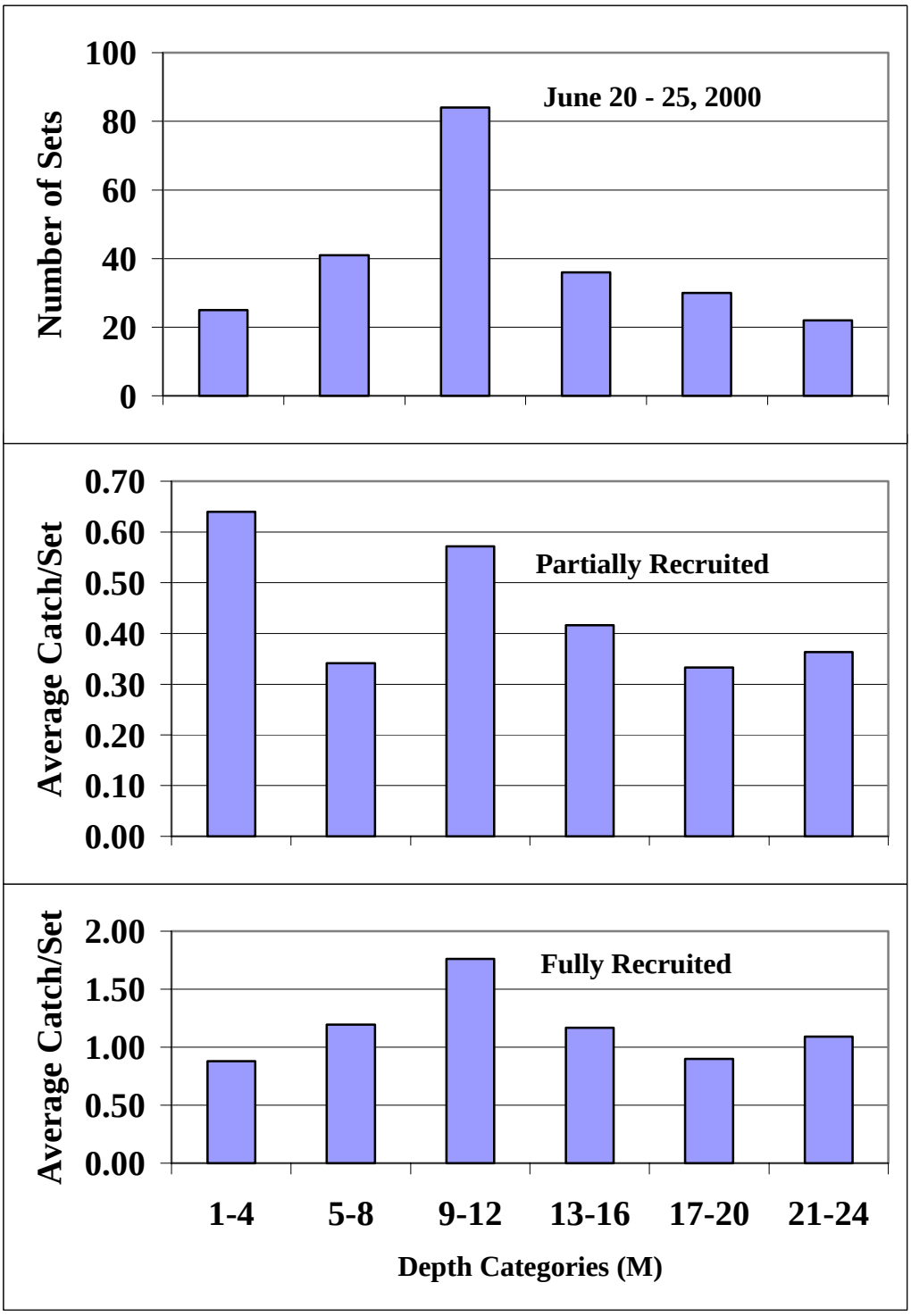

Figure 7.-Number of sets, and average catch per set for partially and fully recruited burbot by depth during June 20-25, 2000 at Fielding Lake.

Table 3.-Midway date, number of days between events, estimates of abundance, survival rate, and recruitment for fully recruited (≥ 450 mm TL) burbot in Fielding Lake, 1984-2000.

Midway Date	Days Between Events	Abundance			Survival Rate %		Recruitment	
		Est.	(SE)	CV %	Est.	(SE)	Est.	(SE)
7/14/84		NA						
	403				64.9	13.7	NA	
8/21/85		325	83	25.5				
	355				54.7	7.0	170	72
8/11/86		335	55	16.4				
	360				66.9	7.0	38	35
8/06/87		234	23	9.8				
	343				89.8	8.1	236	43
7/15/88		426	50	11.7				
	365				84.5	9.3	243	64
7/15/89		582	75	12.9				
	367				72.6	8.4	279	73
7/17/90		698	87	12.5				
	368				69.7	8.8	132	64
7/20/91		618	81	13.1				
	335				49.1	6.6	45	33
6/27/92		348	43	12.4				
	361				65.6	9.7	110	38
6/23/93		337	54	16.0				
	361				73.2	11.2	198	52
6/19/94		445	65	14.6				
	363				61.9	8.9	173	53
6/17/95		448	67	15.0				
	370				52.8	7.2	240	52
6/22/96		472	62	13.1				
	365				57.7	6.6	151	45
6/22/97		419	50	11.9				
	365				51.7	5.2	208	34
6/22/98		423	39	9.2				
	362				74.9	7.5	283	45
6/19/99		598	63	10.5				
	369							
6/23/00								

Table 4.-Mean CPUE, Jolly-Seber abundance, density, catability, and CPUE abundance for fully recruited (≥450 mm TL) burbot from 1988 – 1999 at Fielding Lake.

Date	Mean CPUE	Jolly-Seber Abundance[a]	Density	Catchability Coefficient[b]	Abundance From CPUE
6/29/88	0.815	426	0.792	1.03	568
6/26/89	0.806	582	1.082	0.75	562
6/16/90	0.877	698	1.297	0.68	611
6/24/91	0.709	618	1.149	0.62	494
6/27/92	0.463	348	0.647	0.72	323
6/23/93	0.324	337	0.626	0.52	226
6/22/94	0.525	445	0.827	0.63	366
6/20/95	0.542	448	0.833	0.65	378
6/22/96	0.659	472	0.898	0.73	459
6/22/97	0.668	419	0.753	0.89	465
6/22/98	0.843	423	0.783	1.08	587
6/20/99	1.090	598	1.112	0.98	759
6/23/00	1.320	917[c]			
Average	0.741	484	0.899	0.77	483

[a] Jolly-Seber multi-year mark-recapture estimate.

[b] Mean CPUE multiplied by surface area (538 ha) divided by abundance.

[c] Mean CPUE multiplied by surface area (538 ha) divided by average catchability coefficient.

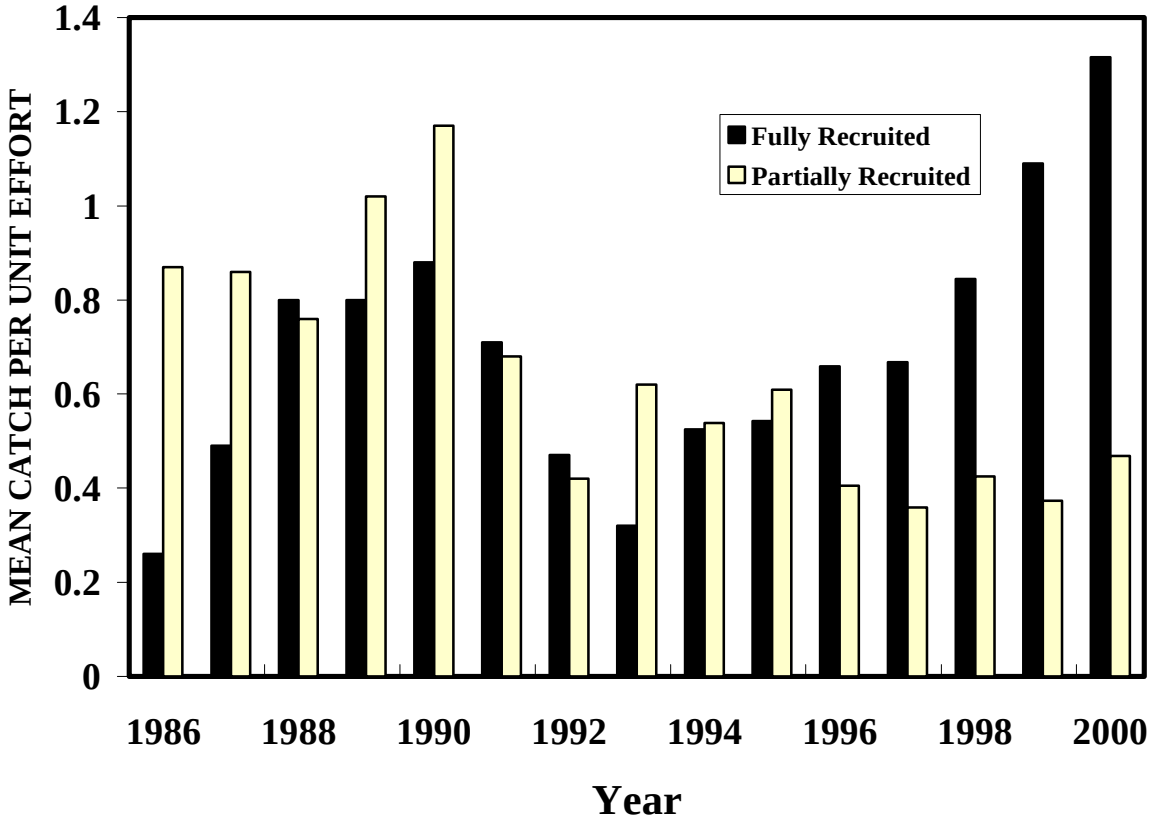

Figure 8.-Mean CPUE of fully recruited (≥ 450 mm TL) burbot and partially recruited (<450 mm TL) burbot captured each spring during sampling events from 1986–2000 at Fielding Lake.

of the population will depend on greater numbers of recruitment (Table 3) than are now observed.

It is believed that potential bias in the estimates of abundance, survival rate, and recruitment from the mark-recapture experiment was negligible. Only one of the 106 fully recruited recaptured burbot, marked in 1999 lost its tag. A secondary mark allowed this recapture to be identified to the marking event. No immigration or emigration has ever been observed from Fielding Lake. Sampling recommendations in Bernard et al. (1991) have been followed closely to avoid other bias.

It is thought that high fishing mortality prior to 1984 caused poor recruitment in succeeding years and a cycle of high and low abundance. Recruits from these years entered the fully recruited population in low numbers beginning in 1992 (Parker 1994). Exploitation of the population from 1992-1994 ranged from 10 to 17%, which was low in comparison to harvests prior to 1984 (Parker 1997). Fishing for burbot was closed in May of 1994 to protect the population (Parker 1996).

In 1999, the population of adult burbot in Fielding Lake appears stronger, even though it appeared in 1997 that another decline in fully recruited burbot had began (Parker 1998; Figure 9). Abundance was predicted to increase by 51% in 1999 to 632 because of the high CPUE (Parker 1999), in fact abundance was estimated at 598 fish in 1999 (Table 3). Estimated abundance based on mean CPUE estimate for 2000 ($\hat{N}$ = 917) predicts that the population will again increase about50% (Table 4). The increase in CPUE in recent years is a result of a greater number of fish available to catch. While current point estimates of abundance, recruitment, and survival rates from the mark-recapture experiment will improve as time passes (statistics will become more accurate as data accumulate). The cyclic pattern observed in the past is changing from a stable population from 1992 to 1998 to one that is now increasing.

As a result of an increase in population abundance in recent years, some harvest can be allowed. A small exploitation rate of 10% of the fully recruited portion of the population size is recommended. This translates to about 60 burbot per year according to the most recent abundance estimate from 1999. In order to meet this objective harvest level, the Alaska Board of Fisheries in January 2001 passed new regulations, which allows a one burbot daily bag and possession limit, prohibits the use of setlines, and imposes a single hook restriction. In addition, fishing is closed during the month of September (primarily to protect spawning lake trout).

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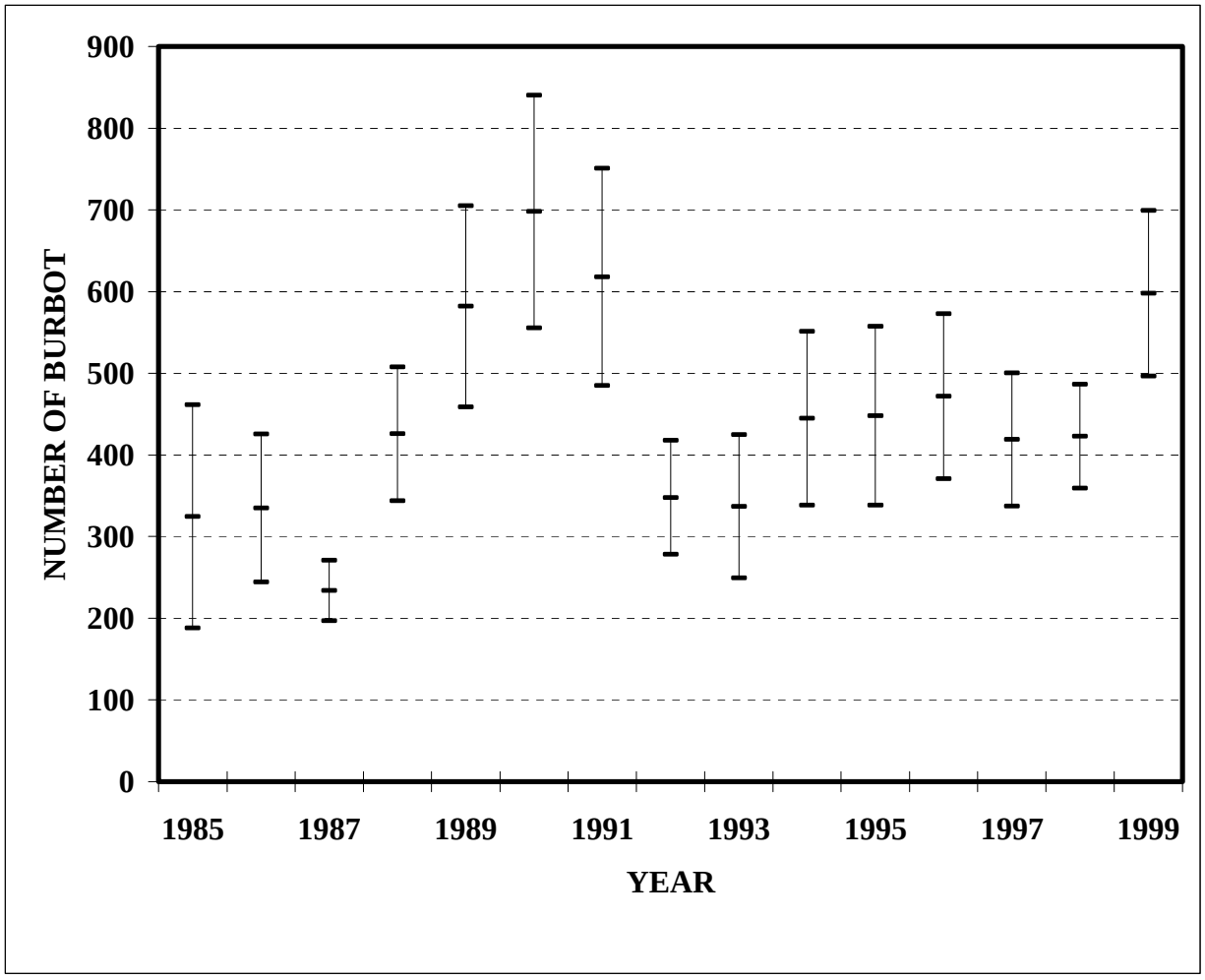

Figure 9.-Estimated abundance (± SE) of fully recruited burbot for Fielding Lake from 1985 – 1999 (note that burbot fishing was closed in 1994).

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APPENDIX A

Appendix A1.-Mark-recapture data of burbot ≥450 mm TL by year (1984-2000) at Fielding Lake.

Date:	Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	Beginning	7/20	7/16	7/28	7/21	6/29	6/26	6/16	6/22	6/24	6/20	6/16	6/14	6/19	6/19	6/17	6/17	6/20
	Ending	10/8	9/27	8/25	8/22	7/31	8/04	8/17	8/18	6/30	6/26	6/22	6/20	6/26	6/25	6/23	6/22	6/25
NUMBER OF FULLY RECRUITED BURBOT:																		
Recaptured from Event 1		0	13	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 2			0	27	23	1	1	1	2	0	0	0	0	0	0	0	0	0
Recaptured from Event 3				0	30	9	2	1	0	2	0	0	0	0	0	0	0	0
Recaptured from Event 4					0	48	18	4	6	4	0	0	0	0	0	0	0	0
Recaptured from Event 5						0	38	16	7	7	2	0	2	1	2	0	0	0
Recaptured from Event 6							0	51	13	5	0	2	1	1	0	0	0	0
Recaptured from Event 7								0	52	18	3	6	2	0	0	0	0	0
Recaptured from Event 8									0	38	8	6	5	1	0	0	0	0
Recaptured from Event 9										0	29	16	5	2	0	1	0	0
Recaptured from Event 10											0	24	8	5	0	0	0	0
Recaptured from Event 11												0	31	18	3	2	1	0
Recaptured from Event 12													0	30	10	9	1	0
Recaptured from Event 13														0	53	15	5	4
Recaptured from Event 14															0	52	18	2
Recaptured from Event 15																0	100	19
Recaptured from Event 16																	0	81
																		0
Captured with Tags		0	13	29	55	58	61	73	80	74	42	54	54	58	68	79	125	106
Captured without Tags		43	149	90	93	117	120	152	108	67	45	103	99	150	113	163	206	207
Captured		43	162	119	148	175	181	225	188	141	87	157	153	208	181	242	331	31`3
Released with Tags		43	138	76	126	149	177	223	187	140	87	156	145	199	178	240	331	309

Appendix A2.-Mark-recapture data of burbot <450 mm TL by year (1984-2000) at Fielding Lake.

Date:	Year	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
	Beginning	7/20	7/16	7/28	7/21	6/29	6/26	6/16	6/22	6/24	6/20	6/16	6/14	6/19	6/19	6/17	6/17	6/20
	Ending	10/8	9/27	8/25	8/22	7/31	8/04	8/17	8/18	6/30	6/26	6/20	6/20	6/26	6/25	6/23	6/22	6/25
NUMBER OF FULLY RECRUITED BURBOT:																		
Recaptured from Event 1		0	19	6	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 2			0	50	23	4	4	0	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 3				0	29	13	2	0	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 4					0	28	5	2	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 5						0	31	5	0	0	0	0	0	0	0	0	0	0
Recaptured from Event 6							0	38	5	0	0	0	0	0	0	0	0	0
Recaptured from Event 7								0	24	2	4	0	0	0	0	0	0	0
Recaptured from Event 8									0	12	6	0	0	0	0	0	0	0
Recaptured from Event 9										0	13	7	0	0	0	0	0	0
Recaptured from Event 10											0	11	6	1	0	0	0	0
Recaptured from Event 11												0	9	2	0	0	0	0
Recaptured from Event 12													0	10	3	0	0	0
Recaptured from Event 13														0	7	1	0	0
Recaptured from Event 14															0	9	0	0
Recaptured from Event 15																0	11	2
Recaptured from Event 16																	0	7
																		0
Captured with Tags		0	19	56	52	46	42	45	29	14	23	18	15	13	10	10	11	9
Captured without Tags		65	432	278	230	175	244	274	168	112	142	143	164	110	95	115	101	102
Captured		65	451	334	282	221	286	319	197	126	165	161	179	123	105	125	112	111
Released with Tags		65	404	233	163	152	279	308	194	121	158	160	170	117	104	124	112	111

Appendix A3.-Sex, age, length, weight, and maturtiy of burbot killed during sampling by date in 2000 at Fielding Lake.

Date Killed	Sex	Age	Length (mm)	Weight (kg)	Maturity
6/25/00	Female	6	500	0.85	Mature
6/24/00	Female	6	478	0.55	Immature
6/24/00	Male	8	520	0.70	Mature
6/24/00	Male	10	720	2.05	Mature

Appendix A4.-Summary of data archives.

Location	Project Leader	Storage Software and version
Region III	J. F. Parker	Comma delimited
Delta Junction	895-4632	ASCII files Standard
		RTS Archive format [a]

	Data Map		
Study Area	File Name	Data Format	Software
Fielding Lake	U-01300H012000.DTA	Hoopnet	RTS-ASCII
	Fielding burbot 2000-TH.XLS	Spreadsheet	Microsoft Excel

Definitions of Data Formats:

Hoopnet: an mark-sense form developed by Alaska Department of Fish and Game, Division of Sport Fish Research and Technical Services (RTS) for the recording of trap, catch, and tagging information.

Tag History: a Excel file that contains lake specific historical tagging information by individual tags and recaptures by sampling events.

Specific codes and organization of columns for each data format are available on request from RTS.

[a] Alaska Department of Fish and Game - Sport Fish Division - Research and Technical Services (RTS).

Appendix A5.-Contour map of Fielding Lake updated in 1999 using more accurate charting methods.